Patient Preparation for Oncological FDG-PET/CT Imaging

Onkolojik FDG-PET/BT Görüntüleme için Hasta Hazırlığı

Patient Preparation for PET/CT Imaging

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Özet

Pozitron emisyon tomografisi (PET)/bilgisayarlı tomografi (BT) çekimine giren onkoloji hastalarında tümör metabolizması hakkında nicel ve nitel veri elde etmek için radyoaktif olarak işaretlenmiş [18F]-2-floro-2-deoksi-D-glukoz (FDG) kullanılır. FDG-PET/BT görüntüleme (tarama) öncesi hasta hazırlığı süreci esas olarak, hasta bilgilerinin elde edilmesini, görüntüleme öncesi aç kalınmasını, kan şekeri ve insülin seviyelerinin düzenlenmesini, hastaya FDG- radyolojik kontrast maddeler ve yardımcı ajanların verilmesini, yeni tedavi almış hastalarda görüntülemenin ne zaman yapılacağının planlanmasını, gebelik ve emzirme dönemindeki görüntülemeyi ve görüntüleme öncesi son düzenlemeleri içerir. Onkolojik FDG-PET/BT görüntülemede hasta hazırlığı işlemlerinin standardize edilmesi, yüksek kalitede görüntülerin elde edilmesi, yalancı negatif-yalancı pozitif bulguların azaltılması ve hastanın aldığı radyasyon dozunun olabildiğince düşürülmesi için son derece önemlidir.

Anahtar Kelimeler

Fluorodeoksiglukoz F18; Pozitron-Emisyon Tomografi/Bilgisayarlı Tomografi; Hastalar; Tıbbi Onkoloji

Abstract

In oncology patients who undergo positron emission tomography (PET)/computed tomography (CT), radiolabeled [18F]-2-fluoro-2-deoxy-D-glucose (FDG) is utilized to obtain qualitative and quantitative data about tumour metabolism. The process of patient preparation before FDG-PET/CT imaging (scanning) primarily includes acquisition of patient data, fasting before imaging, regulation of blood glucose and insulin levels, administration of FDG and radiologic contrast material, administration of adjunctive agents, scheduling of the imaging in recently treated patients, imaging during pregnancy and lactation, and final arrangements before imaging. Standardization of procedures for patient preparation in oncological FDG-PET/CT imaging is extremely important to obtain high-quality images, to decrease false-negative and false-positive findings and to reduce the patient radiation dose as much as possible.

Keywords

Fluorodeoxyglucose F18; Positron-Emission Tomography/Computed Tomography; Patients; Medical Oncology

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Introduction

For more than two decades, radiolabeled [18F]-2-fluoro-2-deoxy-D-glucose (FDG) has been used to obtain qualitative and quantitative data about tumour metabolism by means of positron emission tomography (PET) and PET/computed tomography (PET/CT) [1–4]. PET is a cross-sectional method that measures distribution of positron-emitting labelled radiotracers in three dimensions. CT component of the system provides attenuation correction and allows imaging of anatomical structures with a geometric resolution higher than the PET component [5]. The diagnostic value of FDG-PET/CT is based on the fact that most cancers demonstrate increased glucose consumption compared to normal cells [6]. Discrimination of benign and malignant tumours, detection of unknown primary tumors in patients presenting with metastases, staging of cancer patients, imaging of tumour recurrences and monitorization of tumour response to therapy are among the major indications of oncological FDG-PET/CT imaging (scanning) [4, 7–13]. Preparation of the oncology patients for FDG-PET/CT imaging, which is extremely important to obtain optimal diagnostic images and to decrease the patient radiation dose, starts the day before the scanning and includes the procedures till they are positioned on the scanner. In this review, the main steps of the process of patient preparation for oncological FDG-PET/CT imaging are included.

Obtaining patient data

On initial admittance, a patient history should be obtained thoroughly, including past and current diseases (particularly diabetes mellitus), previously performed surgical interventions, all types of therapies (chemotherapy, radiotherapy, medical treatment), any kind of current medication, history of drug allergy, history of renal function impairment, lactation and the possibility of pregnancy [14]. Previously performed imaging and biopsy results should strictly be asked. Height and weight of the patient should be measured [5]. The peculiarity between the patient's size and weight distribution may restrict the area imaged [14]. Renal functions should be checked if intravenous (IV) contrast material (CM) has to be used [5]. After obtaining patient data, the FDG-PET/CT study is scheduled. The length and extent of the study, besides scanning time are all determined according to the indications. Then the patient and the family are informed about the study and they are mentally prepared for the procedures. Finally informed consent has to be obtained from them.

Fasting before FDG-PET/CT imaging

In general terms, the patients should stop eating the night before the morning FDG-PET/CT examinations. A protein-dominant diet, poor in carbohydrates is recommended for the day before the scanning because such a diet decreases competition of dietary glucose with FDG for the process of uptake into the cells. If an overnight fasting is not possible, total fasting for at least 6 h before the scanning, including tube feeding, IV dextrose and hyperalimentation is recommended [15]. A low-carbohydrate, light breakfast at least 4 h before the afternoon examinations can be permitted [5]. During fasting, plain water is allowed and even encouraged, for hydration [15]. Consumption of alcohol, caffeine, and nicotine should be avoided before FDG-PET/CT imaging [16]. If possible, sympathomimetic drugs such as ephedrine should not be taken before the examination because they can increase the FDG uptake of brown fat [17].

Blood glucose and insulin levels

The fasting blood glucose is measured before the administration of FDG to decide whether it is between 70–110 mg/dL, which are accepted as optimal levels for an FDG-PET/CT scan [18]. If the blood glucose level is above 200 mg/dL, the scanning is delayed till better and tolerable glucose levels are obtained [5, 18]. For optimal images, a blood glucose level below 150 mg/dL is preferred [5, 16, 19]. To achieve this, hyperglycemic patients are hydrated orally, given intravenous saline and/or given subcutaneous insulin. But high levels of insulin enhances the FDG uptake of skeletal mucles, heart, bones and liver [16], so the diabetics should stop subcutaneous insulin injection at least 4–6 h before the administration of FDG [5]. In general terms, type II diabetic patients were permitted to take their oral medications before FDG-PET/CT imaging, which was strongly recommended to be performed in the late morning [15]. However there are some drawbacks on some of the oral antidiabetics. Sulfonylurea oral hypoglycemic agents like tolbutamide, glyburide or glipizide increase insulin secretion and therefore, discontinuing these drugs were declared to be necessary before FDG-PET/CT imaging [16]. Since metformin was reported to decrease the diagnostic value of FDG PET/CT by increasing FDG uptake in the colon and the small intestines [20–23], discontinuation of it for two days before the scanning was reported to be feasible [24]. Some commonly prescribed drugs which can increase blood glucose levels, such as glucocorticoids, some anticonvulsants, lithium etc. were not recommended to be discontinued before the scanning [15].

Administration of FDG

A patent venous access is necessary for IV administration of FDG. An FDG dose of about 140 μCi/kg (a total dose of about 10 mCi–20 mCi) is recommended for an FDG-PET scan [18, 25–27]. A total of 10–30 mL saline flush is done after IV FDG injection [26, 28]. In order to allow even biodistribution and sufficient cellular uptake of FDG, the patients should not immediately undergo PET/CT after the injection of FDG, but they should rather wait for at least 40–60 min before the scanning [18, 26, 27, 29, 30]. If it is not possible to place a venous access, FDG can also be administered orally in liquid form with water [16, 18]. The above mentioned waiting time for intravenously administered FDG can also be taken into consideration for orally administered FDG [16]. While waiting for the scan, the patients should relax in a quiet, dimly-lit room on comfortable beds or chairs, avoid moving and even talking which would prevent unnecessary FDG uptake of muscles [5, 31]. In fact, physical activities such as exercise should be restricted 24–48 h prior to FDG-PET/CT imaging [15, 32]. The patients should be warned not to cough or make repeated movements like chewing or fidgeting before and during the scanning [28]. In order to decrease the FDG uptake of brown fat as much as possible, patients should not be exposed to cold prior to imaging, they should put on warm clothes and minimize the area of unclothed skin as much as possible even in summer. The room temperature should ideally be adjusted to avoid chilling of the patients and keep them warm during the uptake of FDG [15]. During waiting or scanning, contamination of the patient with his/her urine should be avoided because such artifacts can cause difficulty in interpretation of the images [28].

Administration of radiologic contrast material

Prior to abdominal PET/CT imaging, diluted iodinated CM or barium sulfate as positive contrast agents are administered orally for the opacification of gastrointestinal system [5, 27, 29, 30, 33, 34]. Water or water-based negative contrast agents were also recommended as intraluminal CMs since they were reported to help increase the quality of the images with decreased artifacts [35]. Though attenuation correction artifacts caused by highly concentrated iodinated CM or barium sulfate can be prevented by water, ingestion of water alone can cause augmented FDG accumulation in the bowel because of rapid reabsorption; therefore adequately diluted positive contrast agents should better be used in case of a need for quantification of FDG uptake [5]. Since IV CM may affect tracer quantification and may lead to artifacts while using CT data for PET attenuation correction [36], there is still some debate about the liberate use of them during the CT stage of an FDG-PET/CT scanning [37]. Heusner et al [36] reported highly iodinated IV CMs as usable agents for PET/CT imaging and recommended to consider their use in future protocols. In their FDG-PET/CT study including patients with suspicious liver metastases from colorectal cancer, Badiee et al. [26] reported that IV nonionic iodinated CM was helpful in demonstration of hepatic metastases and was also useful in defining the features of focal hepatic lesions. Sahani et al [33] used IV nonionic iodinated CM for all their pancreatic FDG-PET/CT examinations. However IV CM is generally not used or needed [19, 27, 29, 30, 37–40].

Other adjunctive agents

Oral hydration starting the day before the imaging till FDG is excreted by urination is recommended, because this will reduce the bladder dose and improve image quality by decreasing the artifact caused by the FDG-accumulated urine [28]. For instance, ingestion of 1 L of water during the 2 h before the administration of FDG is recommended [5]. As another option, patients can be told to drink 1–2 L of water during the 4 h just before the scanning [15]. Since other adjunctive agents such as orally or rectally administered bowel-cleansing agents and/or muscle relaxants are often not well-tolerated by the patients, their use is controversial and not usually recommended [18]. Sedatives such as benzodiazepines should better be reserved for the patients with head-neck tumours to decrease muscle uptake and for the patients with claustrophobia [5]. In absolute need for sedation or general anesthesia, it is recommended to perform the FDG injection prior to the medication [28]. Oral sedatives prior to imaging can be given to children who are anxious and/or are unable to obey the instructions [41]. An oral β-blocker (propranolol) can be given to the patients with high FDG uptake in their brown fat 60 min prior to FDG administration, but their pulse rates and blood pressures should be monitored [15].

Scheduling of FDG-PET/CT imaging in recently treated patients

An interval of at least 10–14 days between the last chemotherapy treatment and FDG-PET/CT imaging is thought to be optimal [15, 42]. An interval of 2–3 months between the last radiotherapy treatment and FDG-PET/CT scanning of oncology patients (particularly of the ones with head and neck carcinoma), is clinically considered to be more appropriate. Although the interval between surgery and FDG-PET/CT imaging depends on many factors including the type of surgery and development of wound-infection, waiting for 6–8 weeks was recommended [5, 15].

FDG-PET/CT imaging during pregnancy and lactation

FDG-PET/CT imaging should be avoided during pregnancy because of the adverse effects of radiation for the fetus [18]. The referring physician should discuss all the clinical findings and previously performed imaging results of the pregnant patient with the nuclear medicine specialist and the radiologist, in order to decide on an alternative imaging tool which may abolish the need for FDG-PET/CT. If FDG-PET/CT imaging has to be done during the postpartum period, breast-feeding should be avoided for 10-24 h after the injection of FDG [16, 18, 28]. Breast milk can be expressed prior to FDG administration to be given to the infant via a bottle later [5].

Final arrangements before imaging

In order to prevent artifacts, the patients should be told to empty their colostomy bags and their urinary bladders, change diapers or other clothings just before the imaging. Also there should be no objects in their pockets. Some water ingestion just before imaging may help decrease salivary FDG secretions [28]. Finally the patient should be positioned on the scanner and scanning should start in accordance with clinical indications, such as from base of the skull to mid-thigh in torso imaging or from the top of the head through the feet in whole-body imaging [5].

Conclusion

Standardization of procedures for patient preparation is necessary in order to obtain high-quality FDG-PET/CT images, to decrease false-negative and false-positive findings, to prevent repeated scanning and thus, to reduce the patient radiation dose as much as possible.

Competing interests

The authors declare that they have no competing interests.

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